Performance of Used Engine Oil in High Strength Concrete and Behavior of the Structure under Dynamic Loading

By

Mohamad Attirillah Mohamad Rosalan(6290)

Dissertation submitted in partial fulfillment of the requirements for the

Bachelor of Engineering (Hons)

(Civil Engineering)

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Universiti Teknologi PETRONAS

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Civil Engineering Programme
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Approved by,

(AP DR. NASIR SHAFIQ)

Universiti Teknologi PETRONAS
Tronoh, Perak

JULY 2008

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

MOHAMAD ATTIRILLAH MOHAMAD ROSALAN

Abstract

There is current trend all over the world to investigate waste material as raw material in cement and concrete. This report briefly discusses the preliminary research done and fundamental understanding of the Performance of Used Engine Oil in High Strength Concrete and Structure Behavior under Dynamic Loading. The objective of project is to determine the performance and dynamic behavior of high strength concrete containing used engine oil as additive and to compare the performance of used engine oil with other admixtures. Other admixtures will be included as a comparison for the used engine oil such as superplasticizer, silica fume and rice husk ash. The dynamic load test was carried out as the age of sample reach 28 days. The dynamic load test is subjected to the fatigue failure. For this project the cyclic load test was carried out until 50000 cycles. Thus all samples were analyzed base on the data and result at 50000 cycles. The samples containing rice husk ash, silica fume and superplasticizer were show great dynamic behavior performance compare to the control mix. But for sample containing used engine oil was showed poor dynamic behavior performance since it was failed at 2600 cycles.

ACKNOWLEDGEMENT

First and foremost, I give thanks and praise to God for His guidance and blessings throughout the entire course of my research. I would also like to sincerely thank UTP, in particular but not limited to Civil Engineering Department for giving me a wonderful opportunity to fulfill my study requirement. The guidance I received from the lecturers and staffs have helped me decide on my future.

My heartfelt gratitude and appreciation is extended to my supervisor, AP Dr Nasir Shafiq for his patience and continuous guidance. Thank you very much for sharing his expertise knowledge, thoughts, and ideas with me. Without his guidance and advice, I would not be able to perform my research project.

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Hopefully my final year research project will be helpful and beneficial to people who are interested to make further research in this field. Finally, thank you very much again and certainly, it would be impossible to complete the final year research project without help from all of them.

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Chapter 1

Introduction

1.1 Background

1.11 Wastes used in concrete

With the advancement of industrial activity and improvement of living standards, the amount of waste generated by society has continuously increased and the treatment and disposal of waste is a serious social problem.

Although large amounts of industrial wastes such as blast furnace slag, fly ash, silica fume, rice husk ash, red mud and non ferrous metal slag have been utilized for many years in large amount as raw materials and blending components in the cement industry, there many other unused industrial wastes. For example, combustible waste such as used oils, tires, sludges, rubbers and incineration ash from urban refuse. Because of the complexity and high cost of treatment and disposal of wastes, research is necessary for industry to find uses of the various wastes material.

The cement industry has continuously made great efforts to develop and accumulate the technology for conserving resources and energy and to prevent environmental pollution. Wastes can be used as raw material in cement manufacturing, as component of concrete binder, as aggregates, a portion of aggregate or ingredients in manufactured aggregates. Some wastes can be used as chemical admixtures and additives, which can alter and enhance selected properties of concrete. Several wastes have been reported to be used in concrete (Siddique and Rafat, 2008):

- Recycled aggregate concrete is wisely used inroad construction.
- Pozzolans such as fly ash, silica fume, granulated blast furnace slag, rice husk ash and other industrial waste are used as extenders of Portland Cement.
- Use engine oil as an air entraining agent in concrete mix.

1.12 High strength concrete

High strength concrete by ACI definitions covers concrete whose cylinder compressive strength exceeds 6000psi (41.4 MPa). Proportioning concrete mixtures is more critical for high strength concrete than for normal strength concrete. The procedure is similar to the proportioning process for normal strength concrete except that adjustments have to be made for the admixtures that replaces part of the cement content in the mixture and often for the need use smaller aggregates in very high strength concrete.

1.13 Used engine oil

It is estimated that less than 45% of used engine oil is being collected worldwide while the remaining 55% is thrown into the environment. Used oil affects both marine and human life because used engine oil contains some toxic material that can reach humans through the food chain. Historically, the leakage of engine oil into the cement in older grinding showed the greater resistance to freezing and thawing of concrete. It showed that adding used engine oil to fresh concrete mix could be similar to adding an air-entraining chemical admixture thus enhancing some durability properties of concrete. However, experimental data on use engine oil in high strength concrete appear to be lacking (Siddique and Rafat, 2008).

1.14 Air entraining agent

Air entraining agent are vinsol resins that produce small air bubbles of 0.05 – 1mm diameter evenly spaced in the concrete mix which can fill the air voids that are expected to be at a spacing of approximately 0.10 – 0.25 mm (A.M.Neville, 2002). The advantages of adding air-entraining agents or admixtures to the concrete mix can be summarized as follows:

- Reduce the water/cement ratio.
- Improve the durability of the concrete surface by reducing the freezing and thawing effects.
- Increasing the concrete resistance to deicing chemicals

1.15 Fatigue Failure

In many structures, repeated loading is applied. Typical of these are bridges, road, offshore structures subjected to the wave and wind loading and airfield pavements; the number of cycles of loading applied during the life of structure may be as high as 10 million.

In materials science, fatigue is the progressive and localised structural damage that occurs when a material is subjected to cyclic loading. The maximum stress values are less than the ultimate tensile stress limit, and may be below the yield stress limit of the material.

1.2 Problem statement

High strength concrete is the structure that basically being used for high rise building, dam, bridges, road and airfield pavement. There are a lot of research has been done in order to produce practical and cost effective high strength concrete. However, until today not much of research regarding the performance of used engine oil in high strength concrete base on the dynamic loading test. Therefore, this project will focus on the dynamic behavior of high strength concrete with additive of used engine oil.

1.3 Objective

The objectives of project are:

- To determine the performance and dynamic behavior of used engine oil in high strength concrete base on the dynamic loading test.
- To compare the performance of several design mixes under dynamic load test.

1.4 Scope of study

The scope of work for this project would be on the performance of the high strength concrete containing used engine oil as additive base on the dynamic loading test. Four reinforced concrete beam specimens will be prepared. Each beam will have different type of mix. The main variables included type of admixtures such as super - plasticizer, used engine oil, silica fume, and rice hush ash. The dynamic loading test will be carried out after 28 day of sample age.

Chapter 2

Literature review

2.1 General

2.11 High Strength Concrete

National Ready Mixed Concrete Association, America (2001) reported that high strength concrete can be defined as high performance concrete that generally with specified compressive strength of 6000psi (40 MPa) or greater. Basically high strength concrete is used to meet certain requirement such as:

- To build high rise building by reducing column size
- To build super structure such as long span bridge and the improve the durability of bridge deck
- To meet the requirement of special application such as durability, modulus elasticity and flexural strength.

The design of high strength concrete should be meet the strength required and other properties of hardened concrete. Some other concept that to be understood for high strength concrete such as:

- Aggregate should be strong and durable. Generally smaller maximum size of coarse aggregate is used for higher strength concrete.
- High strength concrete mixture will have a high cementatious material content that increases the heat of hydration and possibly high shrinkage leading to the potential of cracking.
- High strength concrete basically have low water cement ratio

2.12 Super plasticizer

Super-plasticizers are additives that increase the plasticity or fluidity of the material to which they are added, these include plastics, cement, concrete, wallboard and clay bodies (A.M.Neville, 2002). Although the same compounds are often used for both plastics and concretes, the desired effect is slightly different. Super-plasticizers for concrete soften the mix before it hardens, increasing its workability or reducing water, and are usually not intended to affect the properties of the final product after it hardens. The super-plasticizers for plastics soften the final product increasing its flexibility. Super plasticizer is also high range water reducing chemical admixture. There are four types of super-plasticizer:

- Sulfonate melamine formaldehyde condesates,with a chloride content of 0.005 percent MSF
- Sulfonate melamine formaldehyde condesates,with negligible chloride content of 0.005 percent NSF
- Modified lignosulfonates, which contain no chlorides
- Carboxyl acrylic ester copolymer(CAE)

They are primarily used in concrete mixes in order to accomplish the following effect:

- Increase the workability without altering the mix composition
- Reducing both water and cement content in the mix for the purpose of reducing creep, shrinkage, and thermal strains caused by cement hydration.
- Reducing the mixing water volume and the water cement ratio

2.13 Silica fume

Silica fume is a relatively new pozzolonic material that has received considerable attention in both research and application. It is by-product resulting from the use of high purity quartz with coal in the electric furnace in the production of silicon and ferrosilicon alloys. The use of silica fume resulting in reducing water cement ratio and produce high strength concrete, (A.M.Neville,2002).

Silica fume, also known as microsilica, is a byproduct of the reduction of high-purity quartz with coal in electric furnaces in the production of silicon and ferrosilicon alloys. Silica Fume is also collected as a byproduct in the production of other silicon alloys such as ferrochromium, ferromanganese, ferromagnesium, and calcium silicon (ACI Comm. 226 1987b).

Silica Fume consists of very fine vitreous particles with a surface area ranging from 60,000 to 150,000 ft^2/lb or 13,000 to 30,000 m^2/kg when measured by nitrogen absorption techniques, with particles approximately 100 times smaller than the average cement particle. Because of its extreme fineness and high silica content, Silica Fume is a highly effective pozzolanic material (ACI Comm. 226 1987b; Luther 1990). Silica Fume is used in concrete to improve its properties. It has been found that Silica Fume improves compressive strength, bond strength, and abrasion resistance; reduces permeability; and therefore helps in protecting reinforcing steel from corrosion.

2.14 Used engine oil

Used engine oil can be define as any oil refined from crude oil or synthetic oil that as a result of its use, storage, or handling has become unsuitable for its original purpose, but which may be suitable for further use. Used oil includes crankcase oil, compressor oil, cutting oils, synthetic oils, etc.

Waste crankcase oil (WCO) is defined as used lubricating oils removed from the crankcase of internal combustion engines (Roy J. Irwin, 1997).

The adding of used engine oil in concrete could be similar to adding air entraining agent. By adding air entraining agent, the durability properties may also being increased. This has been proved by Mindess and Young (1981) who reported the leakage of oil into the cement in older grinding units result in concrete with greater resistance to freezing and thawing.

Bilal S Hamad and Ahmad A Rteil (2003) reported that used engine oil acted as a chemical plasticizer improving the fluidity and almost doubling the slump of the concrete mix. The study also shows the increment of air content of the fresh concrete mix which is almost double whereas the commercial air entrainment agent almost quadruple. The adding of used engine oil in concrete will result of maintain in concrete compressive strength whereas the commercial of air entrainment agent caused the lose of 50% of compressive strength of concrete. Bilal also carried out the study for the effect of used engine oil on structural behavior of reinforced concrete elements by using 0.15% used engine oil by weight of cement. The result shows that used engine oil could be used in concrete to improve fluidity and air content without adversely affecting strength properties and structural behavior.

Air-entrained concrete made with a low water cement ratio and an adequate cement factor with low tricalcium aluminate cement will be resistant to attack from sulfate soils and waters. Also, the expansive disruption caused by alkali-silica reactivity is reduced through the use of air entrainment. Results of some carbonation tests reported on plain and air-entrained concrete indicate that air entrainment lowers the carbonation, and therefore provides better protection to reinforcing bars against corrosion due to carbonation. Entrained air improves the workability of concrete, reduces segregation and bleeding in freshly mixed and placed concrete, and increases pump-ability of fresh concrete if introduced in low percentages up to 6%. At constant water cement ratios, increases in air will proportionally reduce strength. For moderate-strength concrete, each percentile of entrained air reduces the compressive strength approximately 2–6% (Bilal S Hamad and Ahmad A Rteil, 2002). Air entrainment also reduces the flexural strength, the splitting tensile strength, and the modulus of elasticity of hardened concrete. The recommended amount of air to be used in air-entrained concrete depends on many factors such as type of structure, climatic conditions, number of freeze–thaw cycles, extent of exposures to deicers, and extent of exposure to sulfates or other aggressive chemicals in soil or waters.

The advantages of adding air-entraining agents or admixtures to the concrete mixture, whether in liquid or powder form are as follows:

a. Reducing the water/cement ratio is used (part of the design mixture water is replaced by the liquid additive).
b. Improving the durability of the concrete surface by reducing or eliminating the freezing and thawing effects.
c. Increasing the concrete resistance to deicing chemical.

2.15 Rice Husk Ash

In the last decades, the use of residue in civil construction, specially in addition to concrete, has been subject of many researches due to, besides to reduce the environmental polluters factors, it may lead several improvements of the concrete properties. The world rice harvest is estimated in 500 million tons per year, and Brazil is the 8th producer. Considering that 20% of the grain is husk, and 20% of the husk after combustion is converted into ash, a total of 20 million tons of ash can be obtained (Mauro M. Tashima, Carlos A. R. Da Silva, Jorge L. Akasaki, Michele Beniti Barbosa, 2004)

In the research done by Mauro M. Tashima, Carlos A. R. Da Silva, Jorge L. Akasaki, Michele Beniti Barbosa (2004) , the rice husk ash was obtained when rice husks are burnt contain mostly silica, which give the pozzolanic properties. The most important property of RHA that determines pozzolanic activity is the amorphous phase content. RHA is a highly reactive pozzolanic material suitable for use in lime-pozzolana mixes and for Portland cement replacement. RHA contains a high amount of silicon dioxide, and its reactivity related to lime depends on a combination of two factors, namely the non-crystalline silica content and its specific surface. By adding RHA to concrete, a decreasing in water absorption was verified. A reducing of 38.7% was observed when compared to control sample. An increment of 25% was obtained when added 5% of RHA was. Moreover, a reducing on waste Portland cement was verified, obtaining the same resistance of control sample. According to the results of splitting tensile test, all the replacement degrees of RHA researched, achieve similar results.

Rice husk ash is a highly reactive pozzolanic material produced by controlled burning of rice husk. The utilization of rice husk ash as a pozzolanic material in cement and concrete provides several advantages, such as improved strength and durability properties, reduced materials costs due to cement savings, and environmental benefits related to the disposal of waste materials and to reduced carbon dioxide missions. Reactivity of RHA is attributed to its high content of amorphous silica, and to its very large surface area governed by the porous structure of the particles. Generally, reactivity is favoured also by increasing fineness of the pozzolanic material (D.D. Bui a, J. Hu b and P. Stroeven, 2004).

2.16 Fatigue strength of concrete

When a material fails under a number of repeated loads, each smaller than the static compressive strength, fatigue in fatigue is said to take place. Both concrete and steel possess the characteristic of fatigue failure.

According to research done by Jonn R. Verna and Thomas E. Stelson (1962) sixty reinforced concrete beam specimens were tested to destruction under repeated loading. These specimens were 78 in. long, 5 in. wide and 4, 5 1/2, or 7 in. deep. They were simply supported over a 72- in. span and loaded at the third points. The test data are for the loading conditions of repeated cyclic loading from 10 percent of ultimate static load to a maximum until failure or 1,000,000 cycles. If no failure occurred the maximum load was in-creased and the program was repeated. The data are presented with parameters for nominal shear stress, nominal bond stress, concrete compression stress and steel tension stress. The interactions of the different modes of failure were interpreted in terms of these stresses. The tests indicated that bond is the mode of failure most susceptible to fatigue damage and that shear or diagonal tension failures are likely to occur if the specimens are not weak in bond. They showed, also, that the mode of fatigue failure depended on the load level as well as the static failure mode.

In **Figure 2.1,** the stress-strain curve varies with the number of load repetition, changing from concave towards the strain axis to a straight line, which shifts at a decreasing rate. It eventually becomes concave towards the stress axis. The degree of this latter concavity is the indication of how near the concrete to failure. Failure will, however, take place only above a certain limiting value of σh, known as fatigue limit or endurance limit. If σ_h is below the fatigue limit, the stress-strain curve will indefinitely remain straight, and failure in fatigue will not take place.

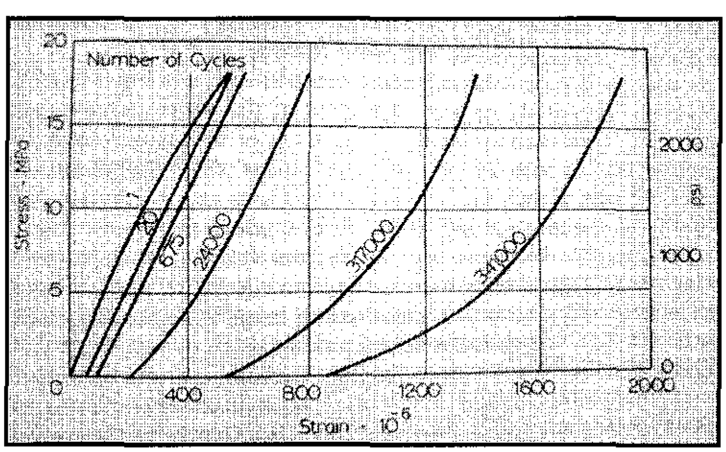


Figure 2.1: Stress- strain curve (A.M.Neville, 2002)

Chapter 3

Methodology

3.1 Introduction

There are some procedures are develop in order to carry out this project. This is to ensure the project flow is smooth and accomplish in the given period.

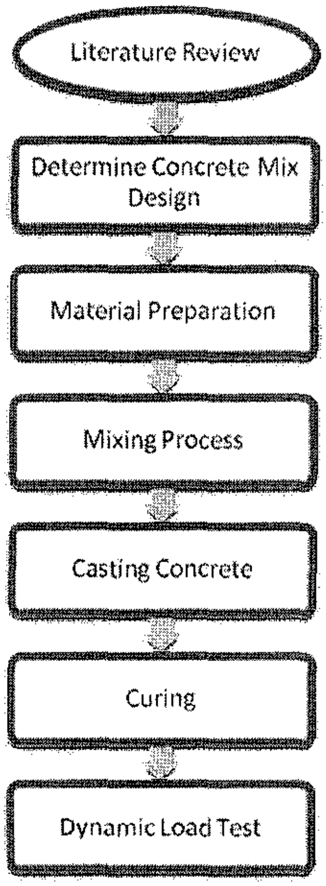


Figure 3.1: Flow Chart activities

3.2 Literature review

To have an understanding of this project, the research has been done by referring the journals, reference books and websites. The research also has been carried out by getting details explanation from supervisor and post graduate's student that has been experienced on related topic of this project.

3.3 Material selection

The cementitious material that has been used in this study was Ordinary Portland Cement while the admixtures were Rice Husk Ash, Silica Fume, Super Plasticizer and Used Engine Oil. For gravel as course aggregate used is 20mm nominal maximum gravel. For sand as fine aggregate used was 3.35mm nominal maximum sand.

3.4 Concrete mix proportion

By considering other admixtures, several mix proportion have been proposed and tested throughout compressive strength test at 28 days. The admixtures that have been used in the design were Rice Husk Ash, Silica Fume, Super Plasticizer and Used Engine Oil. Each mix was designed to be consisted of two different types of admixtures in order to achieve the optimum compressive strength. The detail of mix proportions as follow:

Table 3.1: Concrete mix proportion

Mix	w/c (kg/m3)	MIRHA (%) (kg/m3)	SF (%) (kg/m3)	SP (%) (kg/m3)	UEO (%) (kg/m3)	Cement (kg/m3)	Fine Agg. (kg/m3)	Coarse Agg. (kg/m3)
Control	330	-	-	-	-	600	700	1180
Mix 1	162	-	60	18	-	600	650	1090
Mix 2	230	-	50	-	20	500	690	1150
Mix 3	165	55	-	22	-	550	670	1120

The mix proportions have been recalculated to meet the dimension weight ratio of beam. The design of beam is 140mm x 260mm x 1900mm.

Table 3.2: Concrete Mix design as per 140mm x 260mm x 1900mm

Mix	w/c (kg)	MIRHA (%) (kg)	SF (%) (kg)	SP (%) (kg)	UEO (%) (kg)	Cement (kg)	Fine Agg. (kg)	Coarse Agg. (kg)
Control	23.22	-	-	-	-	42.22	50.07	83.70
Mix 1	14.57	-	5.39	1.62	-	53.94	58.44	98.00
Mix 2	20.68	-	4.50	-	1.80	44.95	62.04	103.39
Mix 3	14.83	4.94	-	1.98	-	49.45	60.24	100.70

3.5 Material preparation

As a reinforced concrete beams, the formwork was fabricated at laboratory and were casted with the dimension of 140mm x 260mm x 1900mm. Plywood were used as material for formwork. Three formworks were prepared for better progress. Two types of reinforced bars were used with size of 12mm and 6mm as a link were prepared. The reinforced bars were bended outside of UTP since the bending machine was not available here. Other material such as coarse and fine aggregates were prepared by cleaning, drying and sieving up to the specification required. The admixtures such as used engine oil, super plasticizer, silica fume and rice husk ash were available at laboratory.

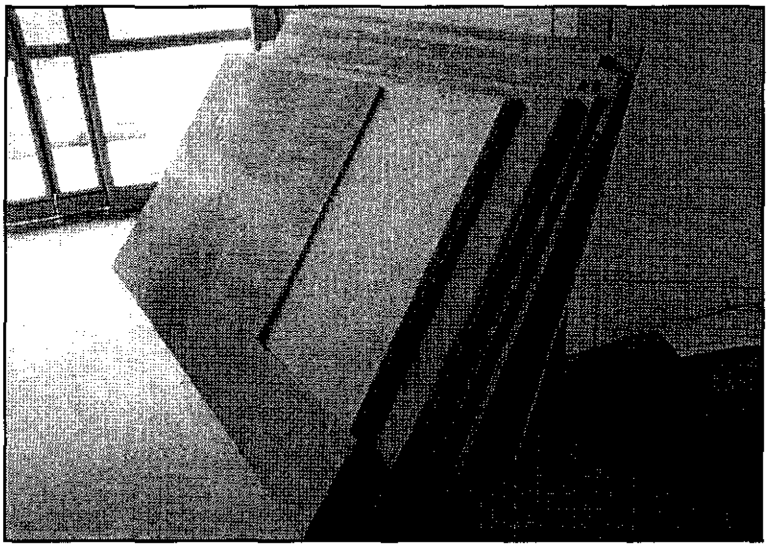


Figure 3.2: Plywood that will be used for formwork

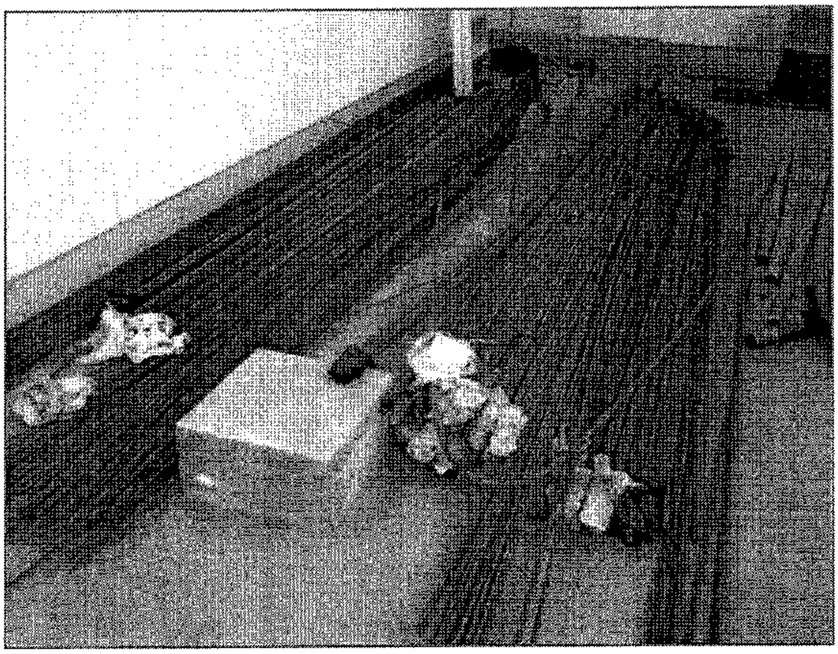


Figure 3.3: Reinforced Bar

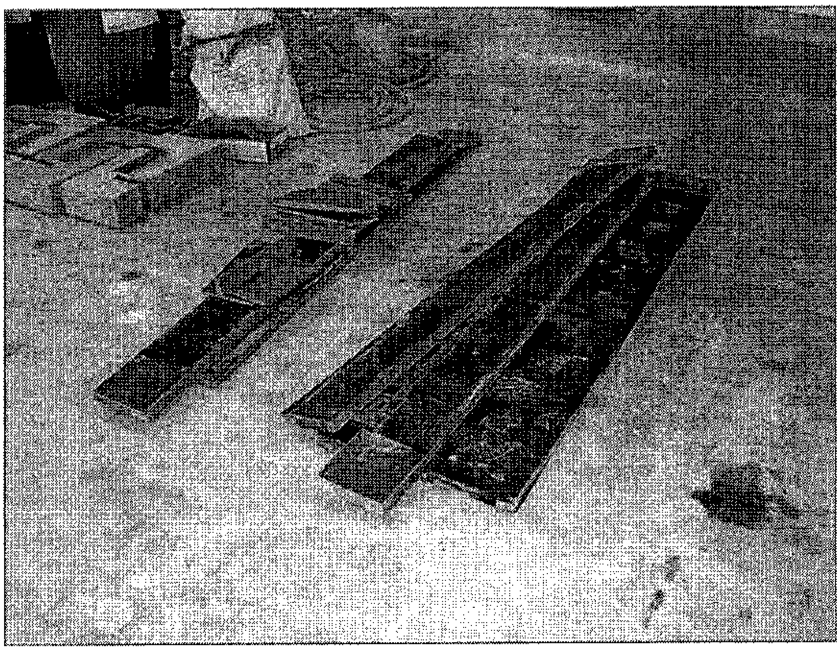


Figure 3.4: Jointing the formworks

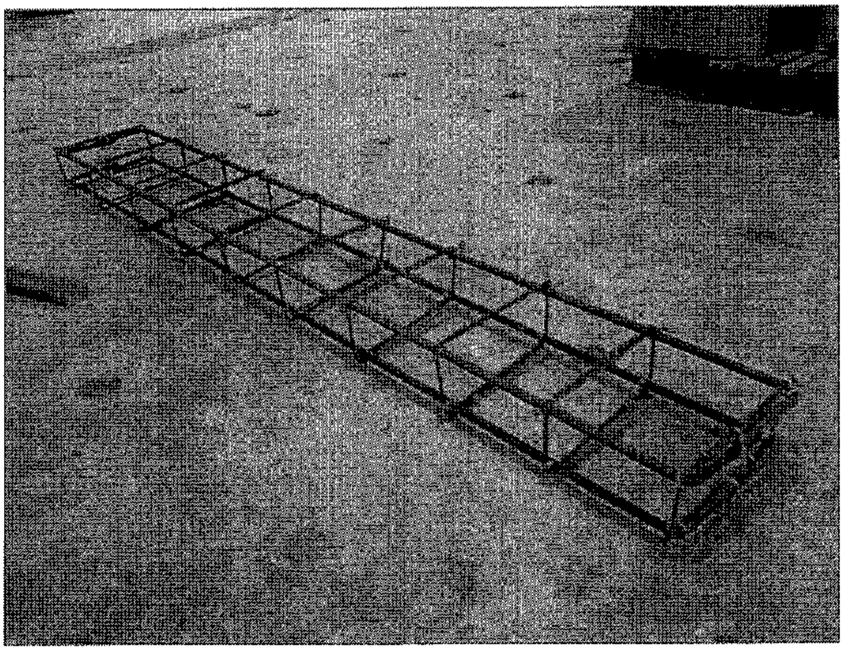


Figure 3.5: Fixing Reinforce Bar

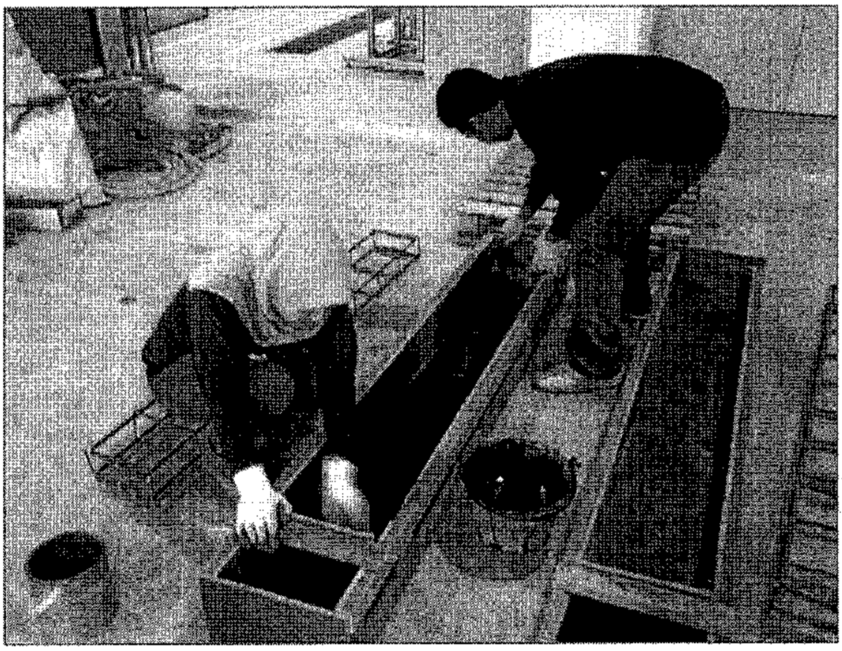


Figure 3.6: Used lubricant oil is applied on plywood surface.

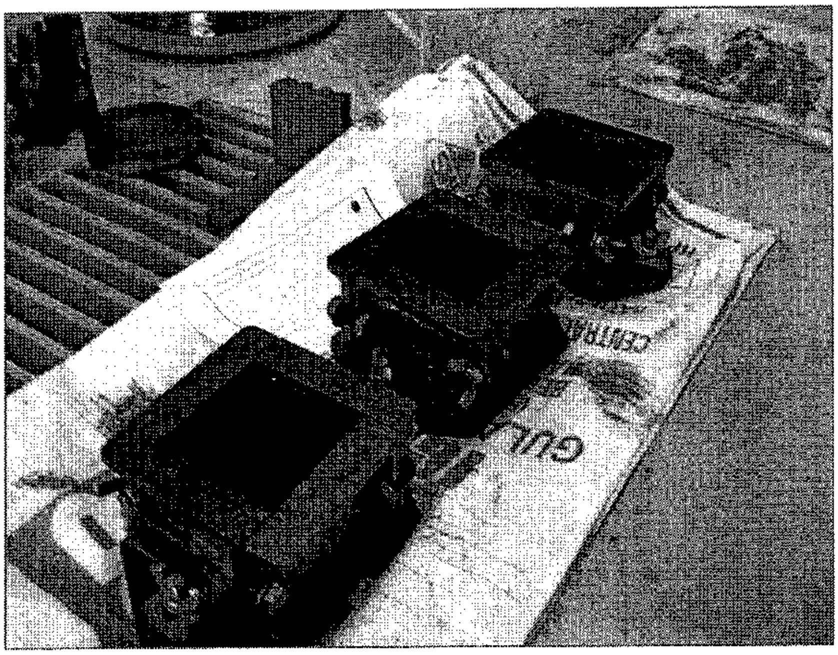


Figure 3.7: Three moulds of 10mm x 10mm x 10mm are prepared.

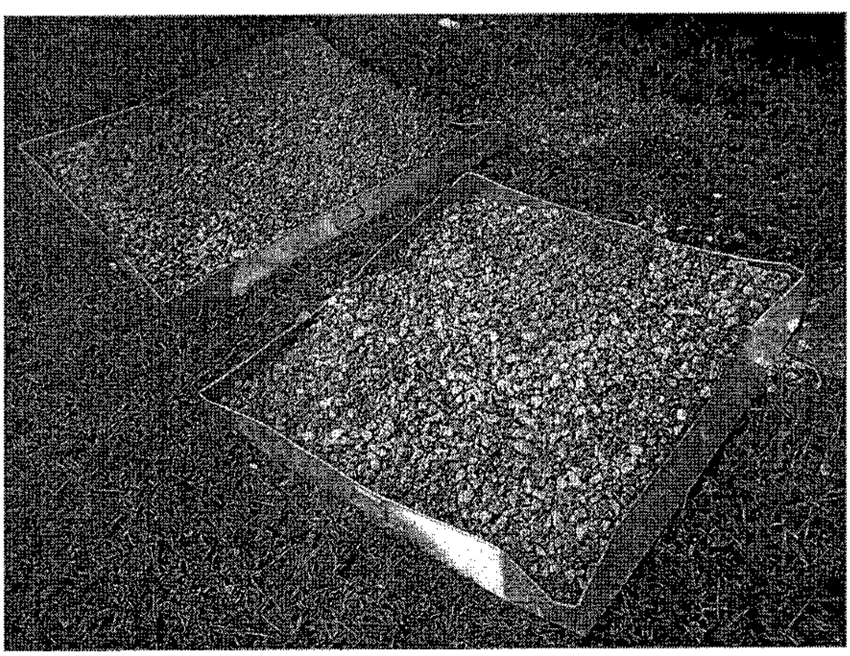


Figure 3.8: Preparation of course aggregate.

3.6 Concrete mixing

The sequence of concrete mix is very important to make sure the mix uniform. The procedures must be as per BS 1881 (Part 125:1986)

1. Wetted the mixer with water
2. Pour all coarse and fine aggregates into the mixer and mix for 25 seconds to ensure uniform distribution between both materials.
3. Pour half of the water and mix for 1 minute.
4. Leave the mixes for 8minutes to let the both coarse and fine aggregates to absorb water.
5. Pour all Portland cement into the mixer and mix for 1 minute.
6. Pour another half of the water and mix for 1 minute.
7. Lastly perform hand mixing until the mix in uniform stage.

Figure 3.9: Author monitoring mixing work.

3.7 Concrete casting

Three formworks made of wood mould for casting the beam. Procedures for concrete casting are:

1. Grease is used to prevent the concrete mix from stick to the formwork by brush the grease to the formwork surface.
2. The formwork size is 1900mm X 260mm X 140mm.
3. Instead of using spacer, the steel wire is used to locate the reinforcement bar in the formwork as per requirement.
4. The concrete mixing are pouring into the formwork by three layers. Vibrator was used to take out the air trapped in the concrete mix for every layer.
5. After a day of casting, the beam was ready for curing process.

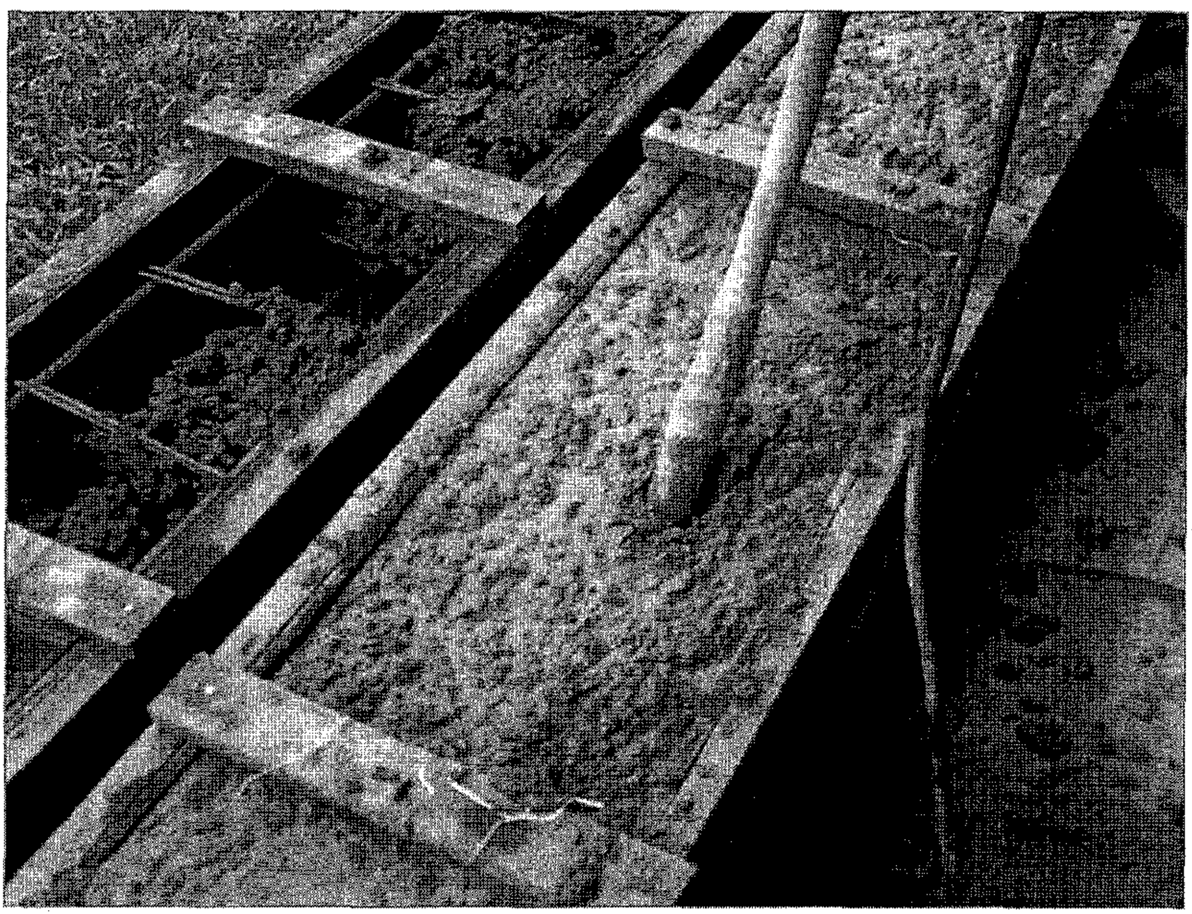


Figure 3.10: Vibrator is used to compact the concrete.

3.8 Curing process

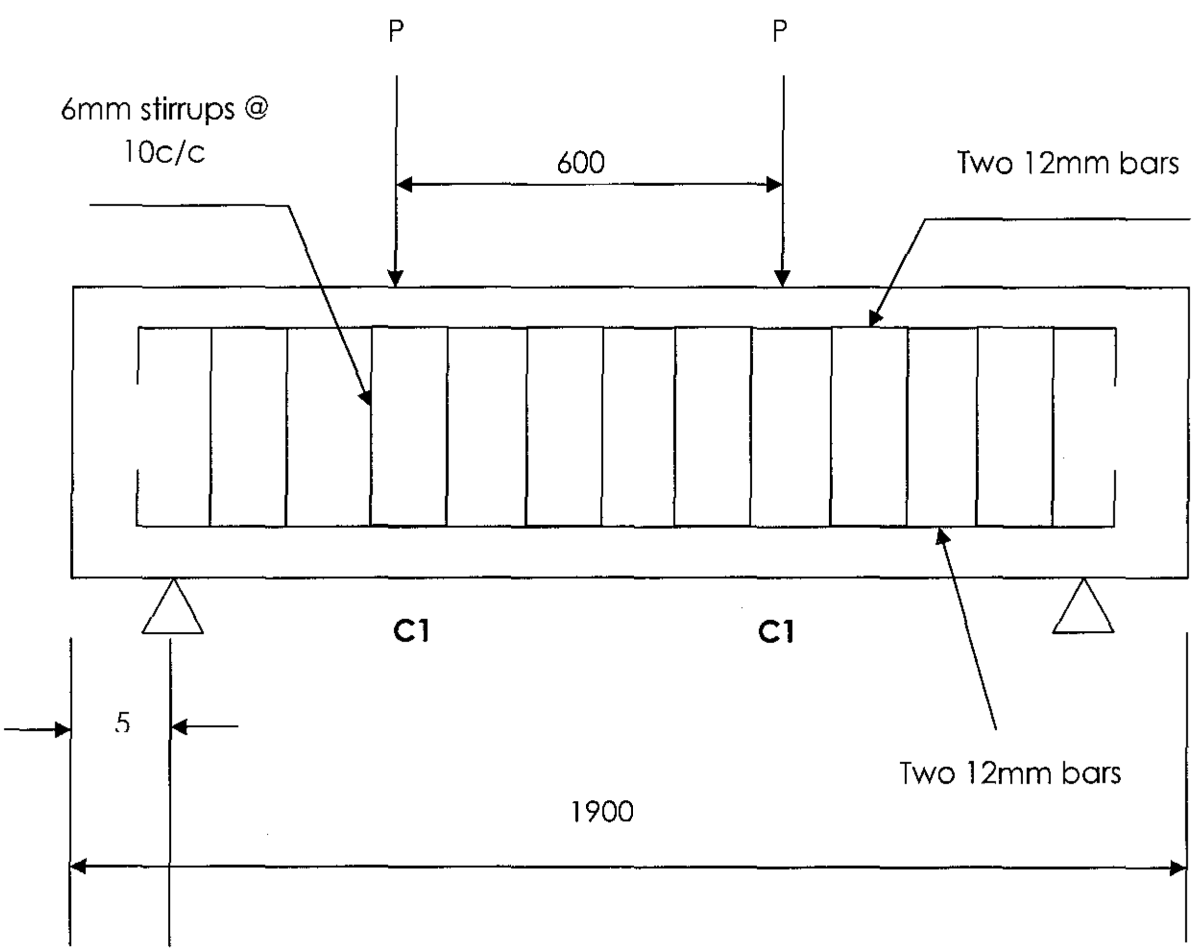
Curing is very important to ensure the concrete is fully hydrated before it acquires strength and hardness. Curing is the process of keeping concrete under specific environmental condition until is relatively complete. Improper curing resulted to several serviceability problems including cracking, increased scaling and reduced abrasion resistance.

In this project, the beams were cured by using wetted jut bags to make sure the concrete beam in the moisture condition and will spray the water for every two days to make sure the beams in wet condition and hydration are fully completed.

Figure 3.11: Jut bags were used to provide moisture to the beams.

3.9 Dynamic Load Test

Four beams including control beam were casted for this study. The reinforced concrete beams were prepared for this project was 1,900 mm long, having a cross section of 140mm X 260 mm and were simply supported over a 1,800 mm span. Two 12 mm bars were selected as flexural reinforcement, and two more were placed in the compression region for fabrication easement. Ten 6 mm stirrups were placed in the beam as shear reinforcement at spacing of 200 mm evenly along the span. A clear cover of 25 mm was provided on all sides.. The beams were loaded in a two point load arrangement with constant moment region of 600mm. The bending of the beam is determined by using LVDT (C1, C2) and data logger equipment. The orientation of the beam is shown in Figure 4.1 and Figure 4.2



Note: all dimensions are in mm

Figure 3.12: Specimen cross- section (side view)

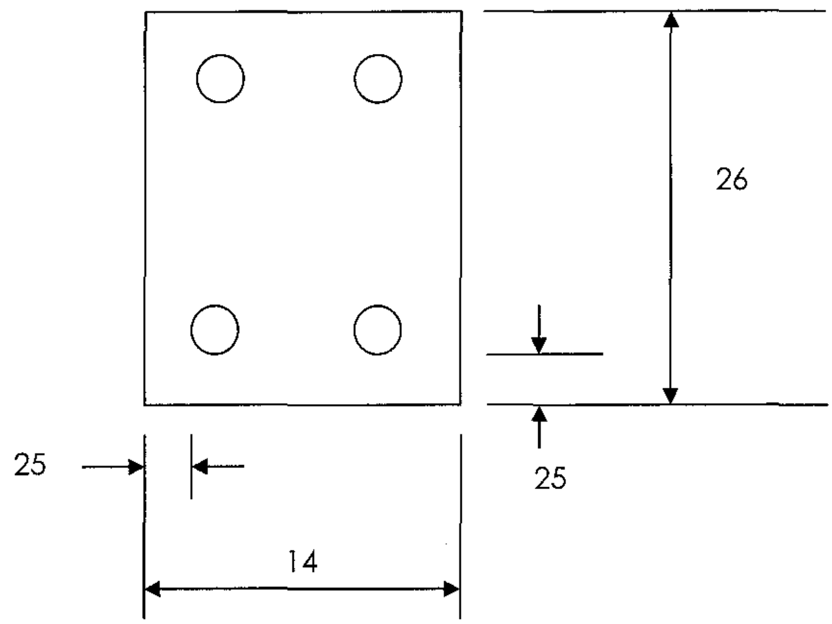


Figure 3.13: Specimen cross section (side view)

The dynamic load test was carried out 28days after casting. The testing were using Universal Testing machine for as mechanism to determine the maximum numbers cyclic load that beams can be sustained before it fail. All beams were experimented to fail under fatigue. Fatigue tests were performed at only one different load range which is 60% for upper load and10% for lower load. Therefore the load range is 60% - 10% of the static ultimate load. All five beams were tested at 60% - 10% load range. The load applied between upper load and lower load level at frequency of 3 Hz. In this project, the maximum numbers of cyclic load were applied was 50000 cycles. Thus, beam s were analyzed base on 50000 load cycles.

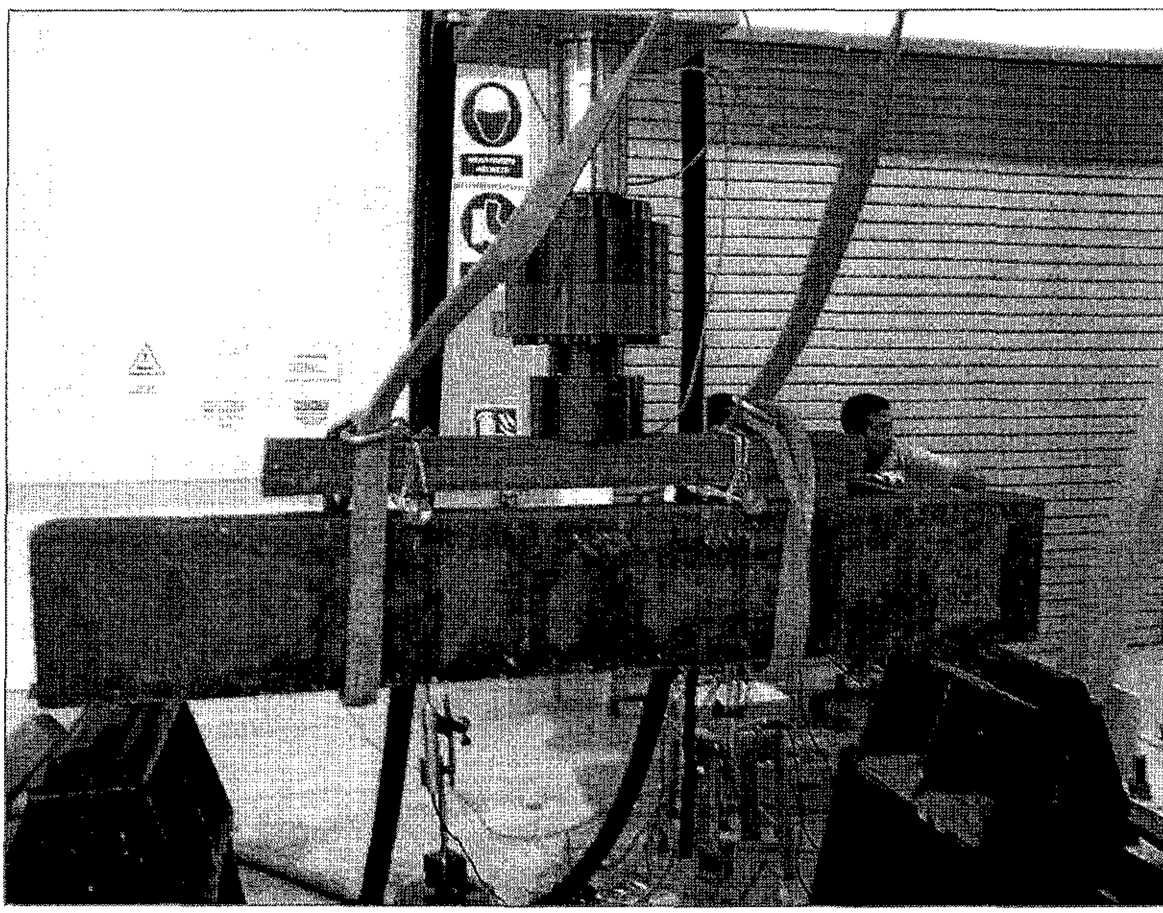


Figure 3.14: The orientation of tested beam.

3.10 Hazard analysis

Table 3.3: Potential hazards and precautions

Hazard	Precautions
Struck by flying material during mixing	Stay at least 2m during mixing.
Dust	Operator must wear dusk mask.
Falling of beam	It should be supported and clamped by the equipment.
Beam hit facility	the work shall be stopped and reported to the Laboratory Officer

Below is the personal protection equipment that being provided at the laboratory.

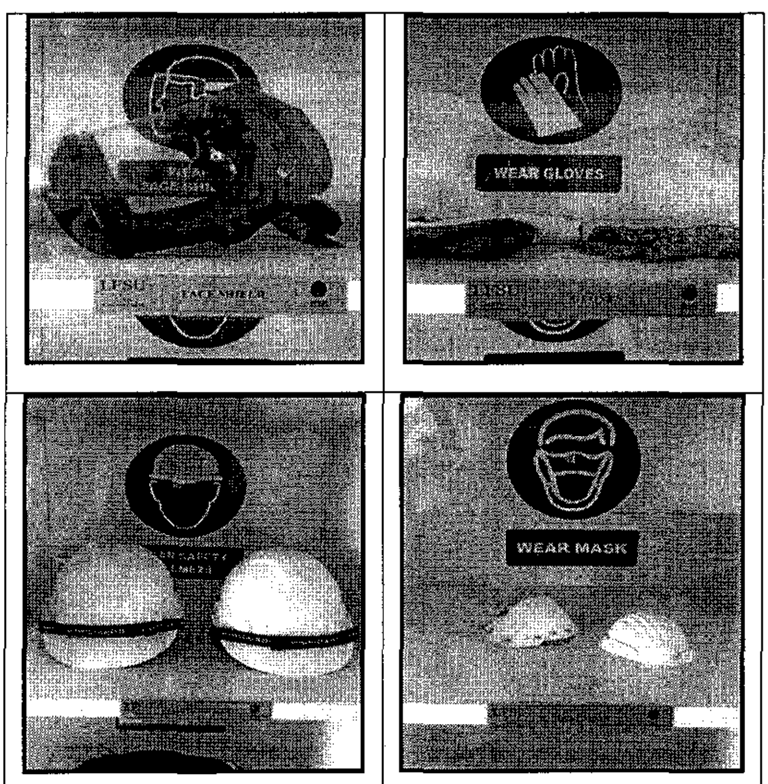


Figure 3.15: Personal protection equipment

Chapter 4

Results and Discussions

4.1 Experimental Results from Fresh and Hardened Concrete Test

Based on result of four mixes that have been done, the conclusions were:

- The slump for all mixes was in the range of 50mm to 90mm which is acceptable. The slump of mixes containing admixtures show higher slump compare to the control mix. Mix 3 that containing used engine oil shows highest slump value which is provide greater workability compares to the other mixes.
- All four samples were achieved required compressive strength.

Table 4.1: Result of slump test and compressive strength

Mixes	Slump (mm)	Compressive Strength (MPa)
Control Mix	50	58.94
Mix 1	90	107.23
Mix 2	90	70.45
Mix 3	120	102.00

4.2 Experimental Results from Dynamic Loading Test

Four beams were tested under cyclic load test. Each specimen was tested with different load capacity. The load capacity was taken from the ultimate load to failure. There was only one load range been used which is 60% - 10%. The 60% was representing the upper load whereas the 10% representing lower load. The load applied between upper load and lower load level at frequency of 3 Hz. In this project, the numbers of cyclic load was limited until 50000 cycles. Thus the specimens were analyzed base on 50000 cyclic loads.

Table 4.2: Result of ultimate load

Mix	Ultimate Load (kN)	60% of Ultimate Load (kN)	10% of Ultimate Load (kN)
Control	108.2	64.92	10.82
Mix 1	121.88	73.13	12.19
Mix 2	136.65	81.99	13.665
Mix 3	117.35	70.41	11.735

4.2.1 Dynamic Analysis

Below are the results of the dynamic load test.

Table 4.3: Result of dynamic load test

Mix	Maximum Cycles	Remark
Control	50000	Failed at 50000 cycles
Mix 1	50000	No significant cracks after 50000 cycles
Mix 2	2600	Failed at 2600 cycles
Mix 3	50000	No significant cracks after 50000 cycles

Base on the table above, Mix 1(containing silica fume and super – plasticizer) and Mix 3 (containing rice husk ash and super – plasticizer) were succeed after 50000 cycles while Control Mix and Mix 2 (containing silica fume and used engine oil) were failed at 50000 cycles and 2600 cycles respectively. After 50000 cycles, Mix 1 and Mix 3 still in good condition and there is no any significant crack. It shows that Mix 1 and Mix 3 have good dynamic behavior performance. The failure of Control Mix and Mix 2 at 50000 cycles and 2600 cycles show the poor dynamic behavior performance. The early failure of the sample like Mix 2 shows the high brittleness of sample.

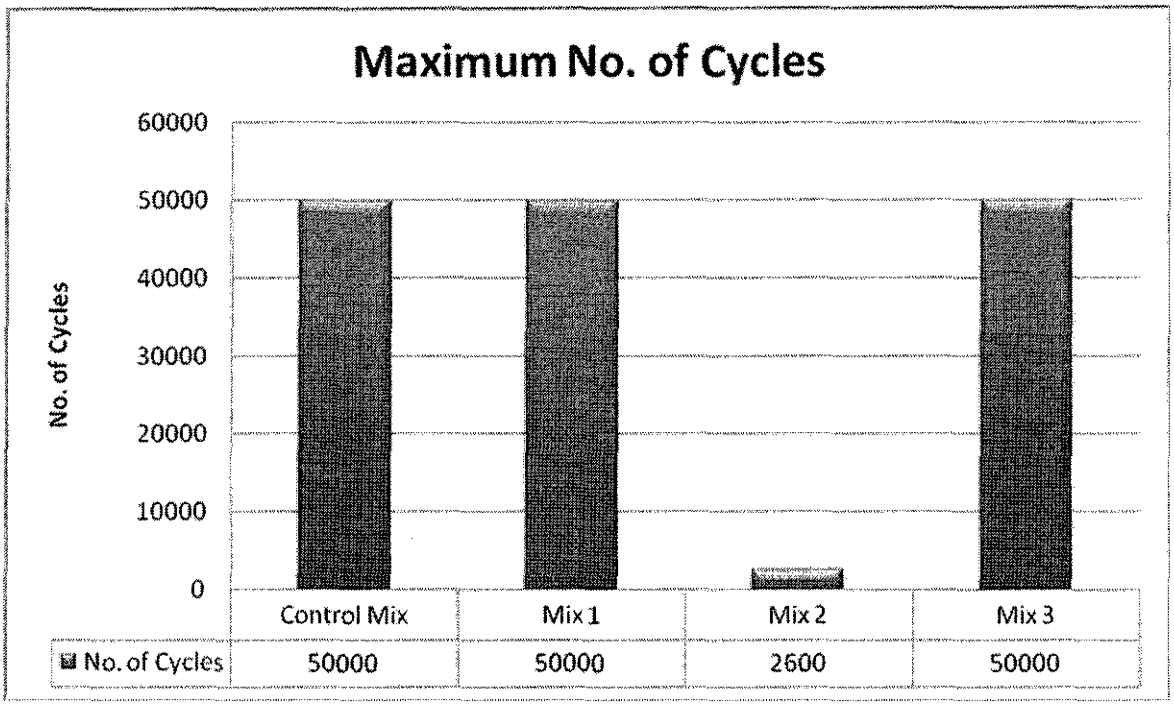


Figure 4.1: Graph of maximum cycles of each beam.

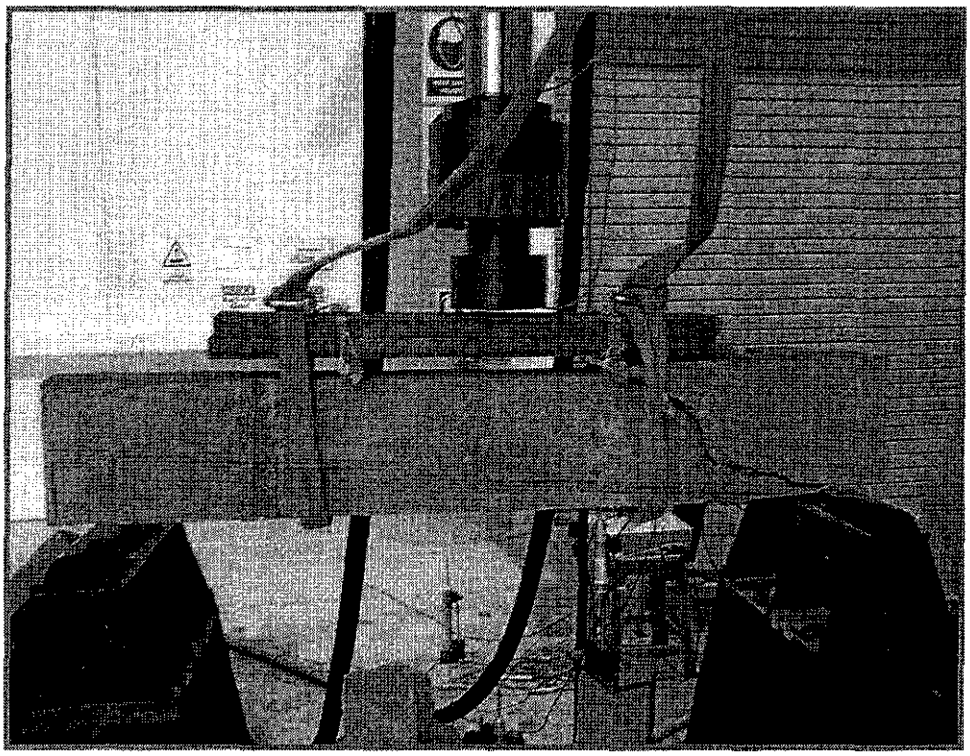


Figure 4.2: Control Mix failed at 50000 cycles.

Mix 2 containing used engine oil and silica fume was failed in shear. The area of cracked was crushed into small pieces. It can be seen in Figure 4.2.

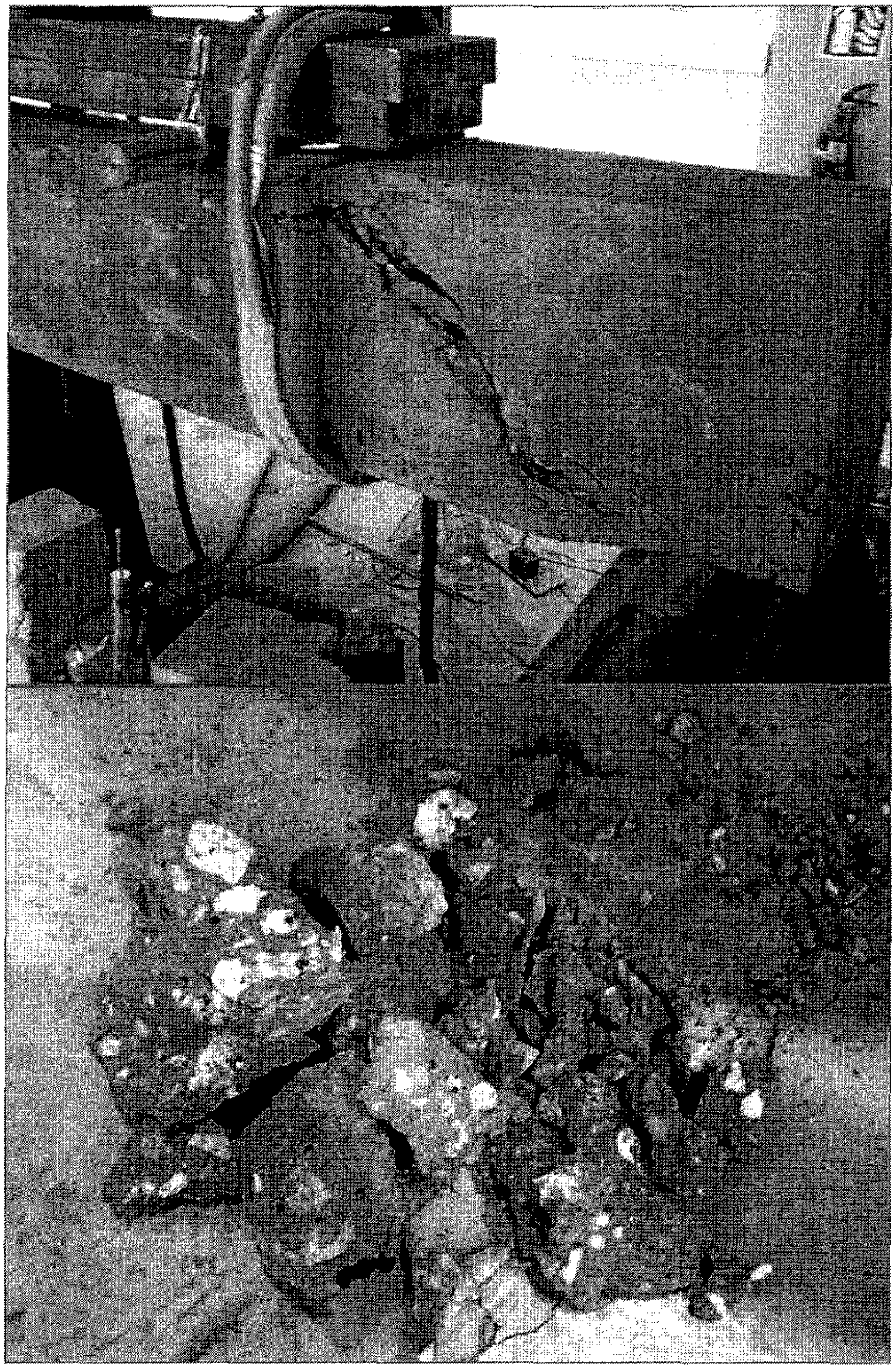


Figure 4.3: The beam was failed in shear (Top); Crushed shows the brittleness of sample (Bottom)

Beams of Mix 1 and Mix 3 were still in good condition and there are no any significant cracks on them. Both beams were shown in Figure 4.3.

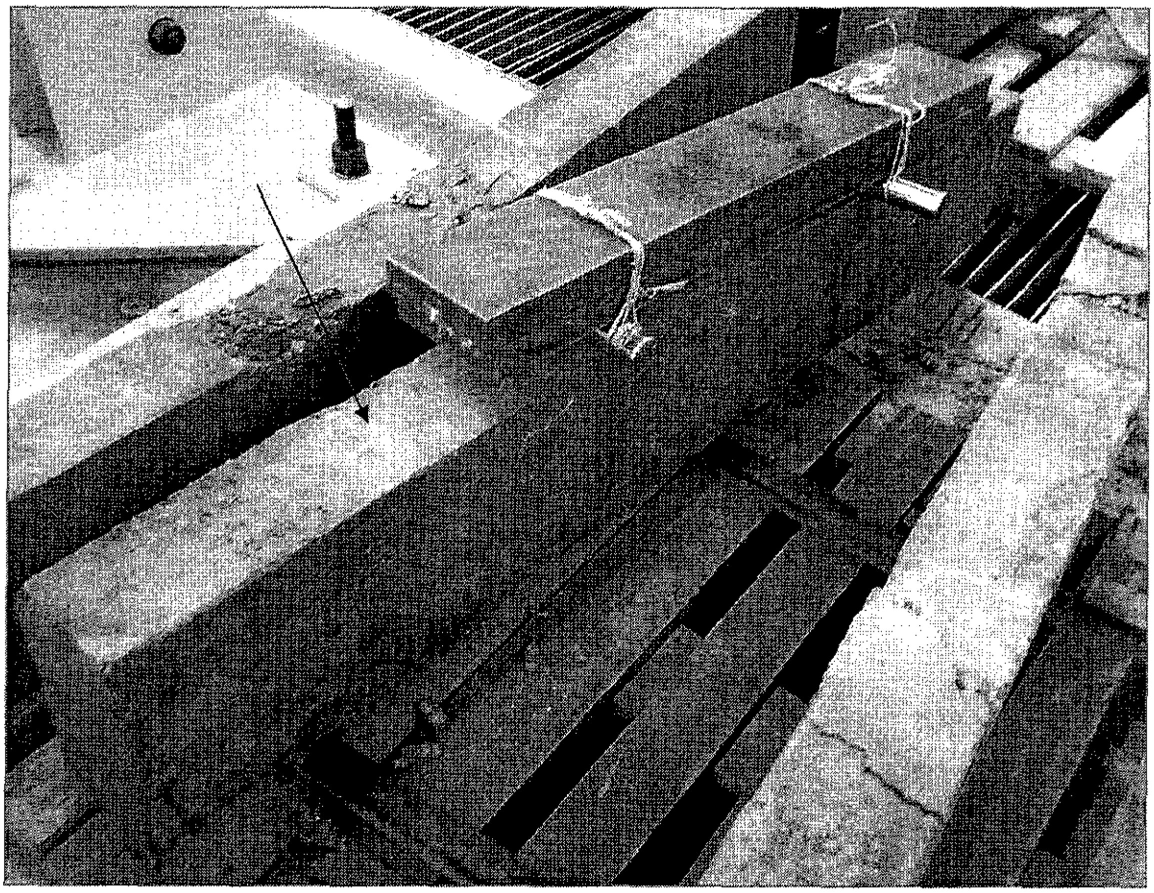


Figure 4.4: Beam Mix 3after test

4.2.2 Deflection Measurements

The deflection was increased with the time. It can be seen in the graph below:

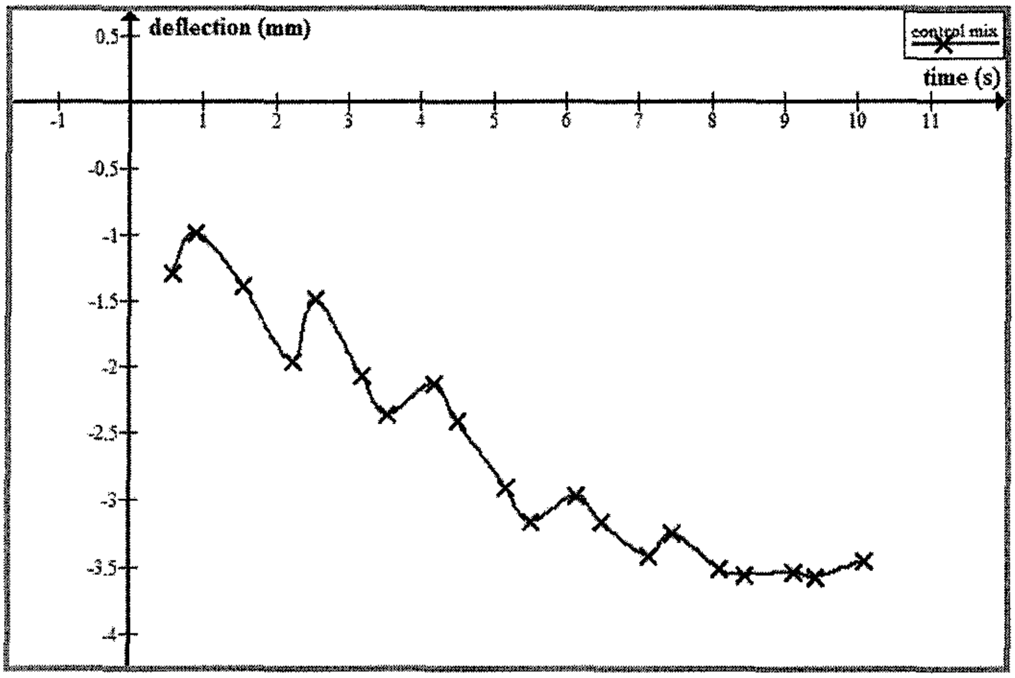


Figure 4.5: Deflection versus Time under Dynamic Test for control mix.

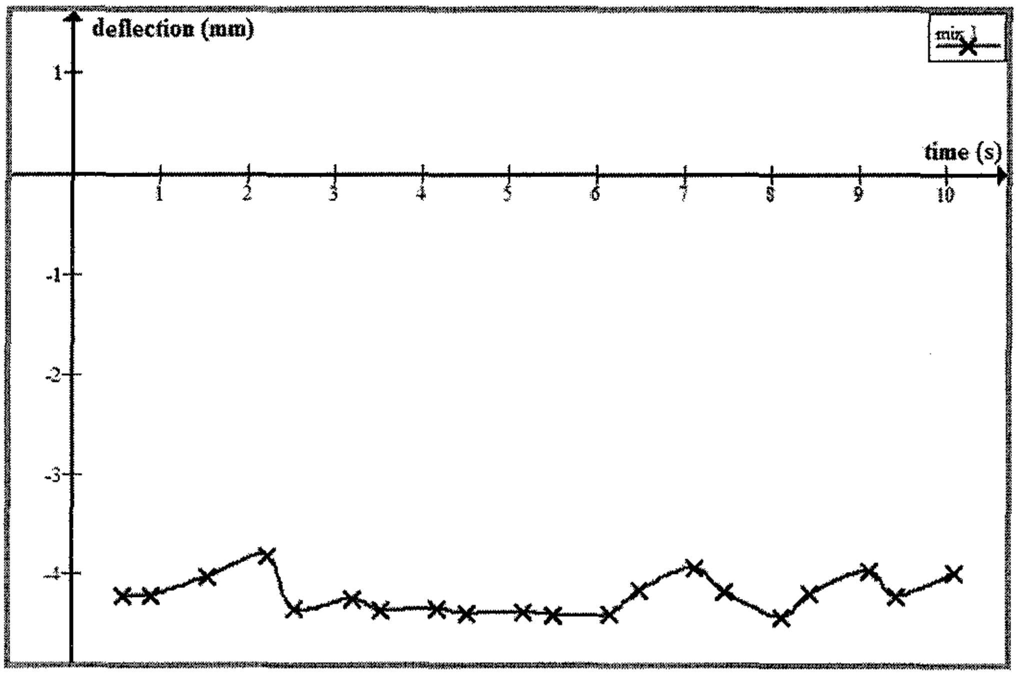


Figure 4.6: Deflection versus Time under Dynamic Test for Mix 1

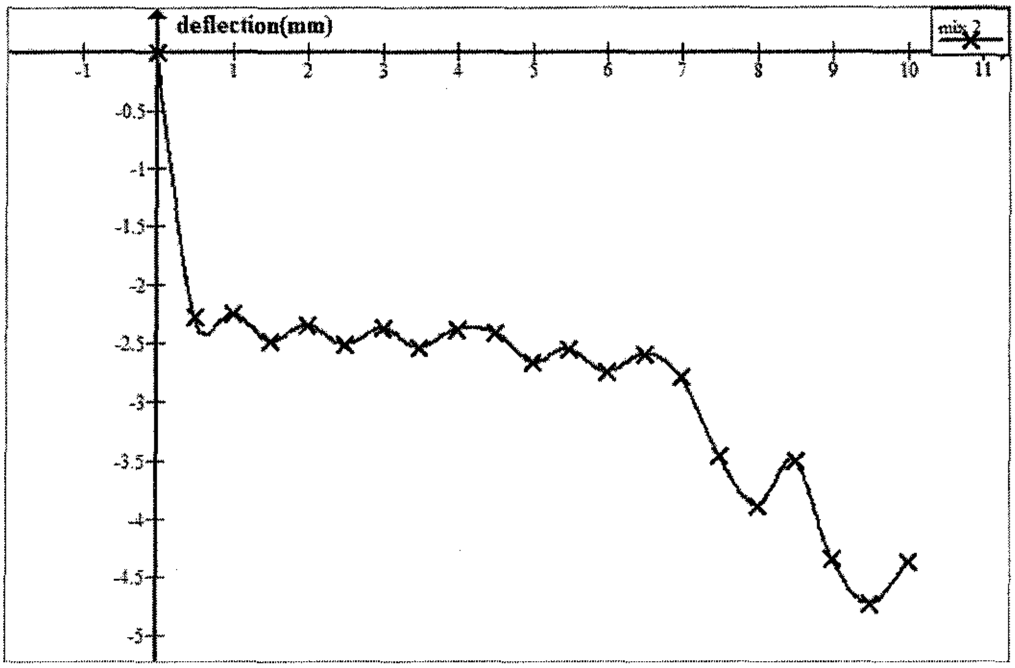


Figure 4.7: Deflection versus Time under Dynamic Test for Mix 2

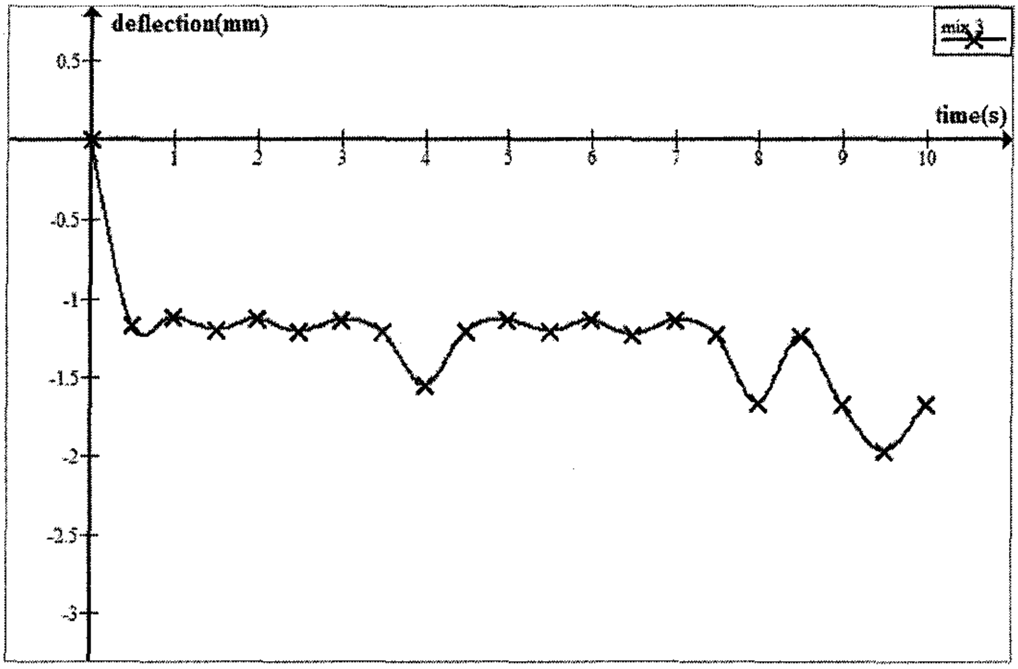


Figure 4.8: Deflection versus Time under Dynamic Test for Mix 3

The load deflection diagrams were presented as below. Base on the diagrams, the deflection also increased with cyclic loads.

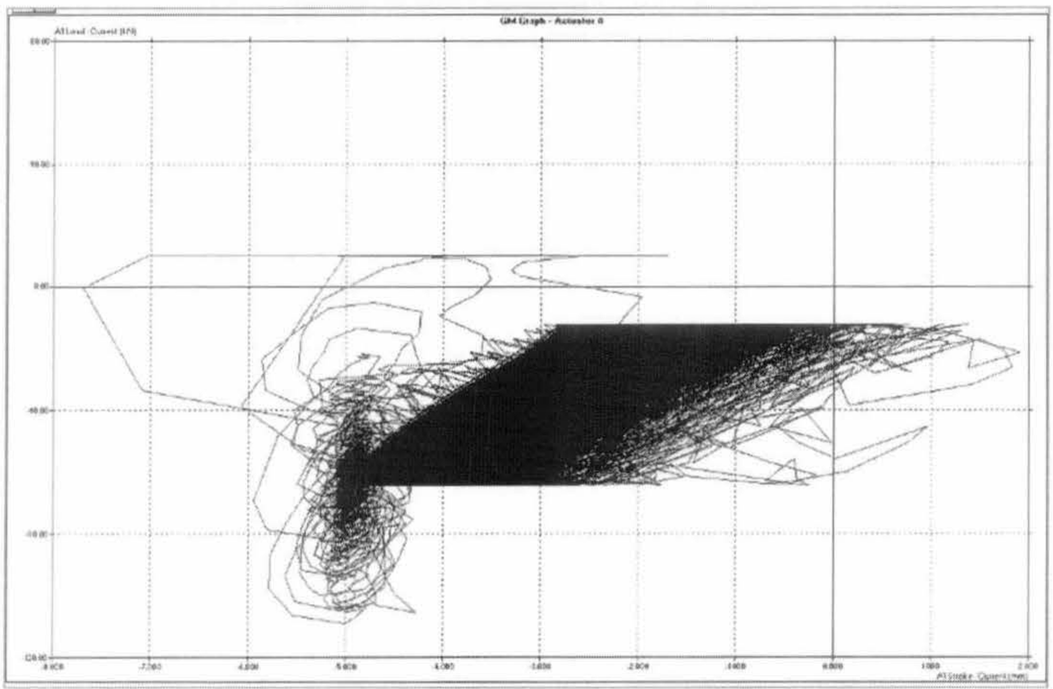


Figure 4.9: Load Deflection under Dynamic Test for control mix.

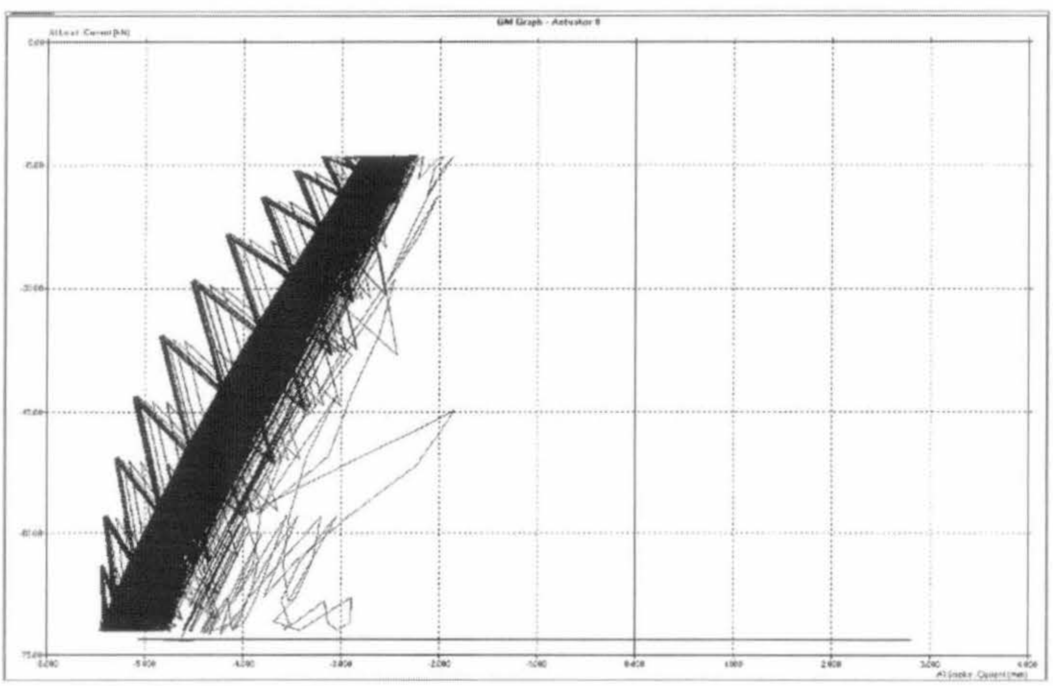


Figure 4.10: Load Deflection under Dynamic Test for Mix 1.

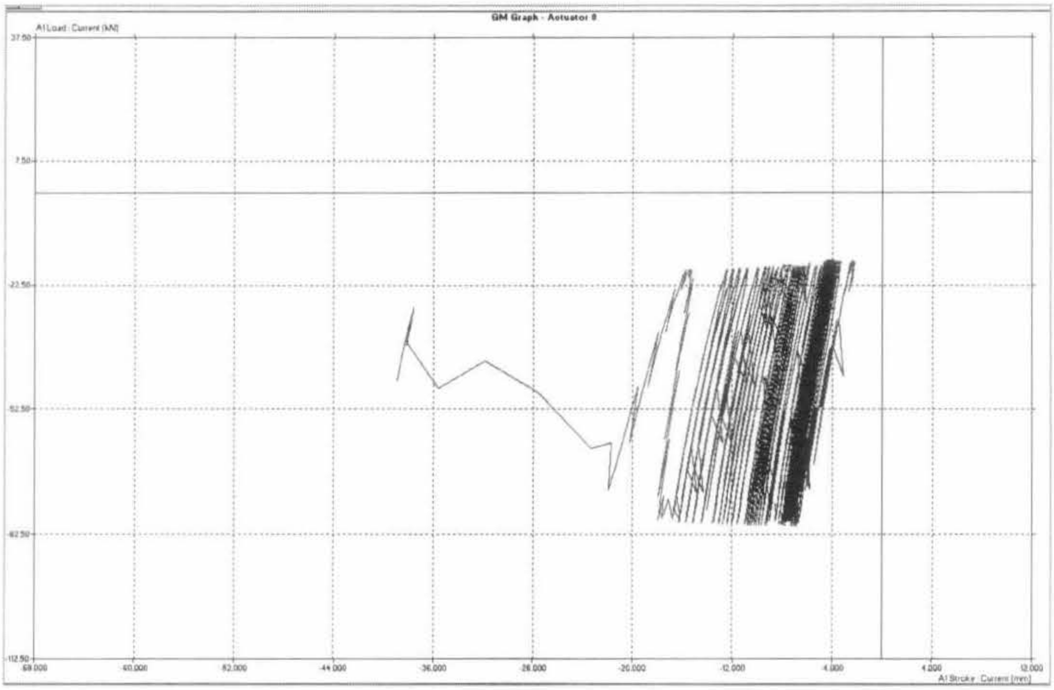


Figure 4.11: Load Deflection under Dynamic Test for Mix 2.

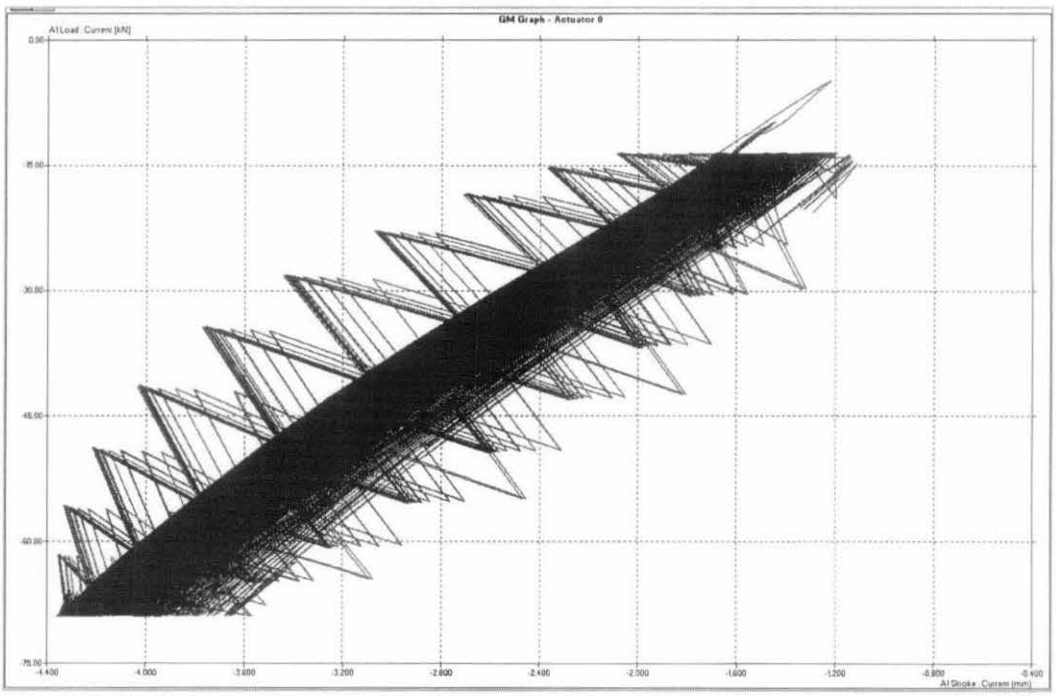


Figure 4.12: Load Deflection under Dynamic Test for Mix 3.

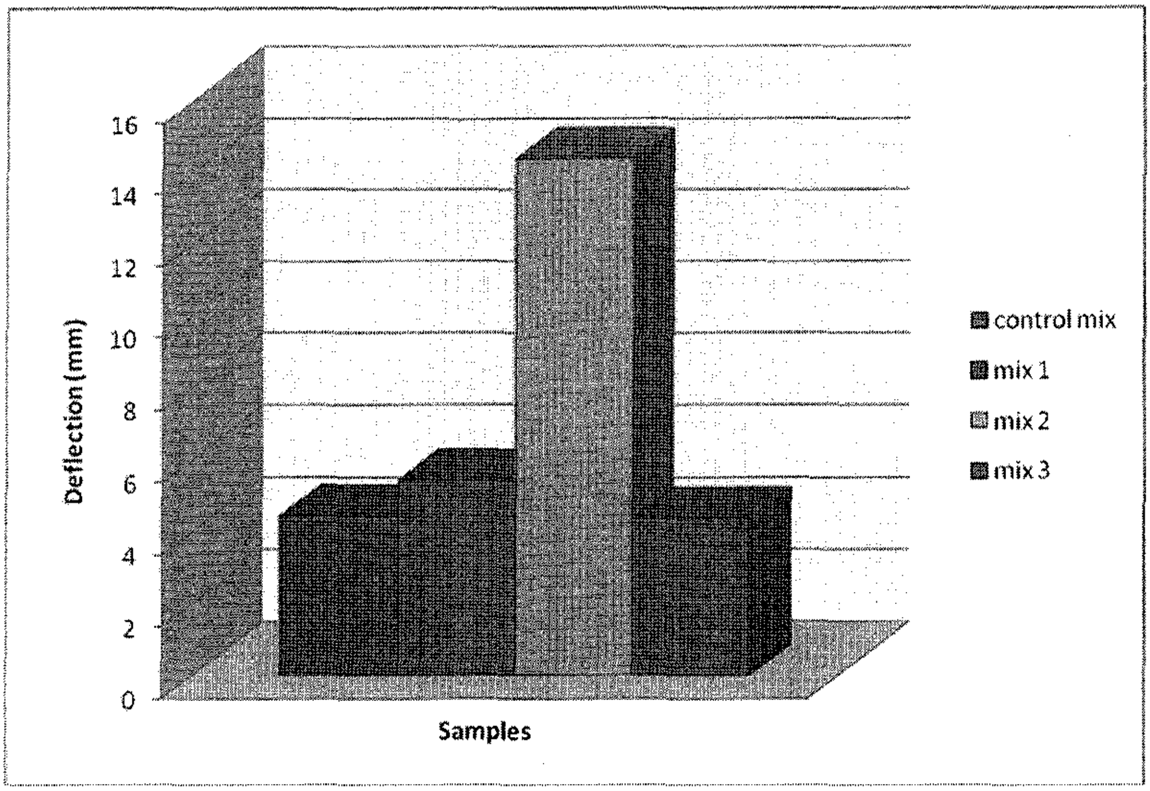


Figure 4.13: The maximum deflection of each beam

Table 4.3: Percentage difference between samples containing admixtures and control mix

Mix	Maximum deflection (mm)	Percentages difference (%)
Control mix	4.426	-
Mix 1	5.423	22.52
Mix 2	14.391	225.14
Mix 3	4.360	1.49

Figure 4.13 shows the maximum displacement of each beam. Base on the diagram, Mix 2 that containing used engine oil and silica fume give the highest deflection compared to other beams. The percentage different between Mix 2 and Control Mix is 225.14%.

4.2.3 Relationship between Dynamic and Deflection

The relationship between number of cycles and deflection is shown in figure. The deflection was increased with number of cycles.

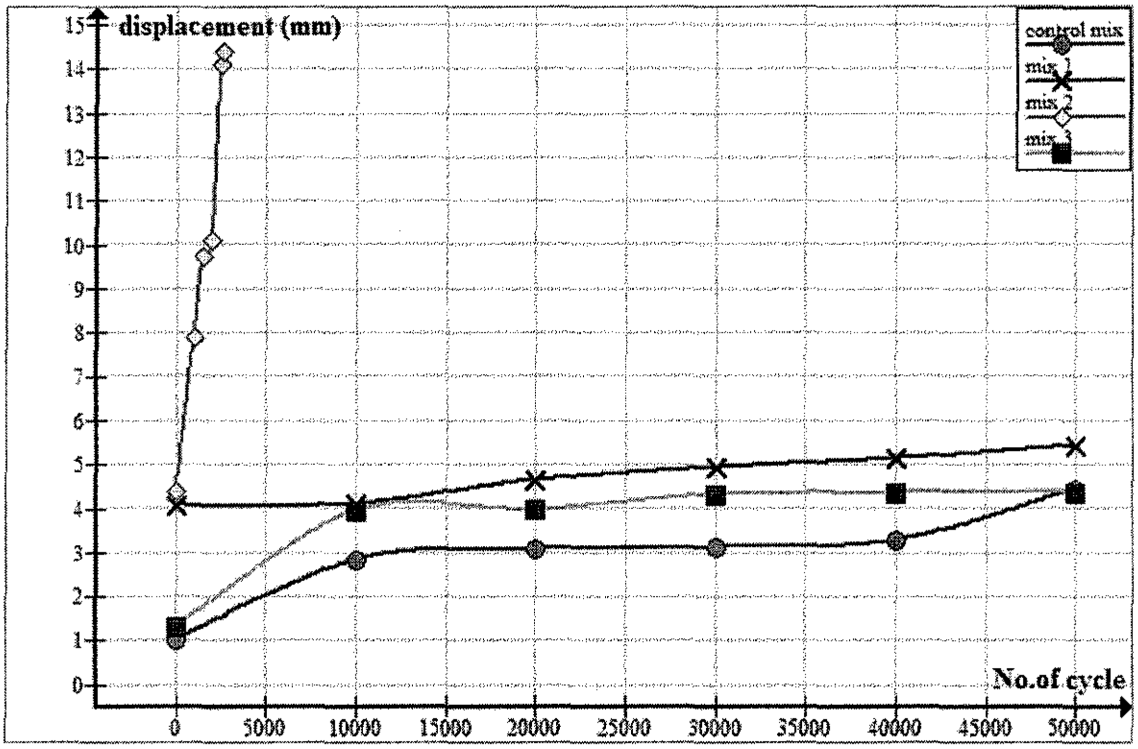


Figure 4.12: Displacement versus No. of cycles under Dynamic Test for Beams

Chapter 5

Conclusion and Recommendation

The high strength concrete containing various admixtures subjected to dynamic load test was studied. Every sample show different dynamic behavior performance. Base on 50000 cycles, the samples that containing admixtures such as super-plasticizer, silica fume and rice husk ash show better performance in dynamic loading compare to control mix. But for sample containing used engine oil and control mix give a poor dynamic behavior performance since it is failed at early of 2600 cycles and 50000cycles respectively. Sample containing silica fume and super – plasticizer has great dynamic behavior performance since it shows a better flexible characteristic compare to the control mix.

Therefore it can be concluded that high strength concrete containing silica fume and superplasticizer can be added into concrete mixing to enhance the concrete performance.

Determining this research resulted to a new era in building construction technology. The used engine oil will be taken for further studies in concrete technology since in this research the used engine oil does not show its capabilities in dynamic performance. Since used engine oil is highly potential in replacement material, therefore further studies should be carried out to improve and enhance concrete performance. As used engine oil can be used as construction replacement material, the construction cost can be reduced and indirectly the pollution and environmental issue regarding used engine oil can be minimized.

This research can be improved by determining a new mix proportion for high strength concrete. The high value of load range also can be reduced to 50%-10% or 40%-10% since the value of load range also the key point of failure. It is also recommended that the researches on used engine oil in concrete and structure technology can be expanded by varying the type of research such as tensile strength test, corrosion test and self compacting concrete.

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